APPENDIX 7

EXAMPLE GPS OBSERVATION SCHEME

ANA Multi-Airport GPS Observation Scheme
Maine ANA Survey, 1998

AIRPORT(S)   Auburn-Lewiston Municipal Airport (LEW)
                              Augusta State Airport (AFN)

Observation Day – Day 1 (045)
Number of Receivers used – 6
CORS Tie: BRU1
A Order Tie – n/a
Observers – Contractor Inc. (2) and Subcontractor Inc. (2)

LEW	AFN
PACS – LEW A Session 1 – 8:00 – 13:30 (5.5 hours) Session 2 – 14:00 – 19:00 (5.0 Hours)	PACS – AUG AP STA C Session 1 – 8:00 – 13:30 (5.5 hours) Session 2 – 14:00 – 19:00 (5.0 hours)
SACS #1 – LEW AP STA B Session 1 – 8:00 – 10:30 (2.5 hours) Session 2 – 14:00 – 16:00 (2.0 hours)	SACS #1 – AUG AP STA B Session 1 – 8:00 – 10:30 (2.5 hours) Session 2 – 14:00 – 16:00 (2.0 hours)
SACS #2 – ARP 1964 Session 1 – 11:00 – 13:30 (2.5 hours) Session 2 – 16:30 – 19:00 (2.5 hours)	SACS #2 – AUG A Session 1 – 11:00 – 13:30 (2.5 hours) Session 2 – 16:30 – 19:00 (2.5 hours)
BM #1 – E171 8:00 – 13:00 (5.0 hours)	BM #1 – G 31 8:00 – 13:00 (5.0 hours)
BM #2 – G 171 14:00 – 19:00 (5.0 hours) HARN – A 196 14:00 – 19:00 (5.0 hours)	

Remarks: Session duration is fixed, start and end times are approximate depending on travel times, dates of survey, satellite status, weather conditions, airport logistics, etc. Stations used for multiple airports are listed on the center of the page.

Detailed station information is listed in the station table.

APPENDIX 8

INFORMATION, DATA, AND SOFTWARE AVAILABLE ON THE INTERNET

Websites

NGS Aeronautical Survey Program:
http://www.ngs.noaa.gov/AERO/aero.html

NGS: http://www.ngs.noaa.gov
NGS presents a wealth of information on its data products, software programs,
and user services, as well as links to other helpful sites.

CORS and IGS Ephemeris Data: http://www.ngs.noaa.gov/CORS/
Information on the National CORS system and access to CORS and Precise Ephemeris data
downloads are available from NGS. Use the "User Friendly CORS" utility to download
customized RINEX data sets and IGS ephemeris. The latest coordinate files and other metadata
for each CORS site is also available. The "Data Availability" feature can be used to determine if
a CORS site is missing data for a particular time period.

USCG Navigation Center GPS Website: http://www.navcen.uscg.gov/
This site provides information on the status of the GPS constellation and provides NANU
message postings and notices for outages at WAAS and DGPS sites.

GPS Antenna Calibration Site: http://www.ngs.noaa.gov/ANTCAL/
This site provides information on which antennas have been calibrated.

Data and Software

PAGE-NT—PAGE-NT is a menu-driven suite of programs used to process GPS data and
is suitable for projects requiring the highest accuracy. A User's Manual, the software, and
sample data sets can be downloaded from the NGS anonymous ftp server:

ftp: ftp.ngs.noaa.gov
login: anonymous
password: your complete email address

Once logged on, go to the /pub/pnt6 directory and download all the files using binary
transfer mode. The input1 and results1 directories contain the sample data sets. Follow the setup
instructions in the PAGE-NT User's Manual.

ADJUST—The ADJUST and ADJUST UTILITIES software package can be downloaded from
NGS (http://www.ngs.noaa.gov) by accessing the "PC Software" link. Check
the site for the latest version of each program. The software performs a least squares
adjustment on horizontal, vertical angle, and/or GPS observations. The program comprises six
data checking programs in addition to the adjustment software. This software package has

numerous options, such as choice of ellipsoid, and includes sample input data. Also available—
is the source code.

ADJUST Utilities—Suite of programs that are used in conjunction with PC program ADJUST.
This group of programs includes the following:

>   **BBACCUR** provides a formatted listing of the external and internal accuracies that have
>   been computed by program ADJUST andsorted in numerical ascending order of external
>   accuracy. Output from program ADJUST, run with accuracies, is used as input.

>   **CLUSTER** is used to identify geodetic stations that are common to two data sets with
>   respect to name or a given position tolerance.

>   **ELEVUP** creates a B-file that combines the B-file output from the constrained horizontal
>   adjustment with the B-file output from the constrained vertical adjustment. This new B-
>   file contains *80* records with adjusted positions from the horizontal and *86* records
>   with the ellipsoidal heights from the horizontal adjustment and the orthometric heights
>   and GEOID heights from the vertical adjustment.

>   **ELLACC** computes ellipsoidal height order and class for a project. Output from program
>   ADJUST, run with accuracies, is used as input.

>   **MAKE86** adds *86* records to the B-file. If the existing *80* records contain
>   orthometric heights, these are added to the new *86* records.

>   **MODGEE** scales the standard errors assigned to the observations in the G-file. Input is a
>   G-file and the scaling factor.

>   **QQRECORD** adds qq records to the A-file (used by program ADJUST) to compute
>   accuracies for all observed lines. Either the G-file (for GPS projects) or the B-file (for
>   classical terrestrial projects) can be used as input.

Data Sheet Utilities—

>   **DSDATA** is the Digital Data Sheet extraction program. Extracts individual or groups of
>   data from a DSDATA file. Includes options to extract by Station Identifier, Station
>   Name, Area, and more.

Other Software Programs—Below is a select listing of other software that is currently
accessible online. For the full and most recent list of NGS programs, visit the NGS PC Software
webpage. Online interactive versions of some of these programs are available from the NGS PC
Software website at http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml.

>   **COMPGB** tests the consistency and compatibility of the Blue Book B-file (GPS project
>   and station occupation data) and G-file (GPS vector data transfer file).

CR8BB reformats GPS project information to fit the requirements of the National Geodetic Survey database. The file created, which is called the B-file, contains project information, station information, and survey measurements. The CR8BB software functions independently of the type of GPS receivers used in a project.

CR8SER extracts data from a GPS Blue Book G-file to create a station serial number file (serfil) for GPS observations.

WDDPROC organizes control point descriptions in accordance with NGS's description file (D-file) format.

DSWIN is Windows-based software for data sheet viewing and extraction. It displays a list of county names as found on your CD. Click on a county and a list of stations appears. Click on a station from the list and a data sheet appears. You may save the data sheet to a file or print it. The search feature allows for filtering the station list by Point Radius, Min/Max Box, Station Name, or PID. You can also filter by type of control, such as first-order bench marks only.

GEOID03 Computes GEOID height values for the conterminous United States, Alaska, Puerto Rico, Virgin Islands, and Hawaii. Suitable for conversion of NAD 83 GPS ellipsoidal heights into NAVD 88 orthometric heights.

HTDP is a horizontal time-dependent positioning software program that allows users to predict horizontal displacements and/or velocities at locations throughout the United States. This software also enables users to update geodetic coordinates and/or observations from one date to another.

INVERSE3D is the three dimensional version of program INVERSE, and is the tool for computing not just the geodetic azimuth and ellipsoidal distance, but also the mark-to-mark distance, the ellipsoid height difference, the dx, dy, dz (differential X, Y, Z used to express GPS vectors), and the dn, de, du (differential north, east, up using the FROM station as the origin of the neu coordinate system). The program requires geodetic coordinates as input, expressed as either (1) latitude and longitude in degrees, minutes, and seconds or decimal degrees along with the ellipsoid heights for both stations, or (2) rectangular coordinates (X, Y, Z in the Conventional Terrestrial Reference System) for each station. The program works exclusively on the GRS80 ellipsoid, and the units are meters. Both types of coordinates may be used in the same computation. The program reads input geodetic positions as positive north and positive west.

LOOP determines the loop misclosures of GPS base lines using the delta x, delta y, delta z vector components computed from a group of observing sessions.

APPENDIX 9

OUTLINE FOR PROCESSING AIRPORT GEODETIC CONTROL SURVEYS WITH PAGE-NT

Outline for Processing Airport Geodetic Control Surveys
with PAGE-NT

1. Place raw data files (zip format acceptable) in the following directory:
:\ProjectName\RawData\DOY\

Project Name is two-letter state ID, plus ANA
DOY = Day of Year of Observation Files

2. Place RINEX data files, TEQC summary file, and precise orbit files (.SP3 format) in the following directory:
:\ProjectName\RinexData\DOY\

3. Ensure the latest sitecors.bin, siteigs.bin, and ant_info.* files are in the :\pnt*\ directory.

4. Create a SERFIL, and place into the following directory: :\ProjectName\serfil\. Create a GFILE directory (:\ProjectName\gfile\).

5. Establish a session processing outline based on the procedures in paragraph 9.6, of this AC. Create a directory for each processing session (:\ProjectName\DOY\DOYS\).

S = Processing session letter

6. Process each session following the procedures in the PAGE-NT documentation.
- Use the latest ITRF coordinates for the Antenna Reference Point (ARP) [or monument if applicable] of each CORS station.
- Ensure the proper antenna height (monument to ARP) and model number is input in the station information menus.
- OMIT the PACS station from the triple difference solution for the PACS to UNKNOWN sessions, and be sure to enter the proper (derived mean) coordinates for the PACS into the station information menu.
- Use the default meteorological values.
- Put in the proper session letter for the session (Merge RINEX Files screen).
- Turn off Tropospheric Unknowns for stations if required (Baseline Processing Options screen: Off = Fix = Not Highlighted; On = Solve = Highlighted in Blue [default]).

7. To run a L1 solution, first run a L3 solution. If the results are satisfactory, rename the output file "combined.sum" to "combinedL3.sum". Return to the Baseline Processing Options screen, and select "L1" for the frequency of solution. Save the change before exiting the menu. Select check box 6 (only) under the RUN menu to run another combined solution. Rename the output "combined.sum" file "combinedL1.sum".

8. Review the combined.sum, float.rms, and fixed.rms files for each session. View plots and other files as necessary to analyze the processing session.

9. Create a G-file for each session by running SINEX2G under the Utilities menu. Ensure the gfile.inp file is correct before each run. Save the individual G-file for each session by naming it DOYSgf and saving it in the gfile directory or processing directory for the session. Run SINEX2G again, appending the session G-file to the project G-file by editing the gfile.inp file to save the file in the :\ProjectName\gfile\ directory with the name "gfile".

10. Submit a hard copy of the processing scheme and a spreadsheet showing the positions and X,Y,Z value differences between sessions for each station. If requested by NGS, also submit hard copies of the following files (for each session) with the processing report.
   - combined.sum, combinedL3.sum, combinedL1.sum
   - float.rms
   - fixed.rms

11. Edit the "#/File Types To Delete During Clean Up" section of the default.txt file to delete only the following files, then run "Clean Up Output Directory" from the Run menu. Submit all of the remaining data in the :\ProjectName\ directory and subdirectories on CD-ROM or other pre-approved medium to NGS with the project report.

Files to be DELETED:
   - *.00
   - *.dat
   - *.scn
   - *.prn
   - *.out
   - *.pom
   - *.new
   - eclipse
   - sum-*.flt
   - sum-*.fix
   - *.sp3
   - *.99o
   - *.99n

12. Place copies of the following files used during vector processing in the :\ProjectName\ directory for submittal:
   - ant_info.*
   - sitecors.bin
   - siteigs.bin
   - default.txt (template)
   - gfile.inp (template)

APPENDIX 10

EXAMPLE COORDINATE COMPARISON SPREADSHEET

Tennessee ANA Survey 1999
Vector Processing Results

Paris Henry County Airport (HZD) - Day 244   CORS - mem2

PACS - HZD A	Observed ITRF Coordinates			SOLN	RMS	KM
	X	**Y**	**Z**	**SOLN**	**RMS**	**KM**
244A	138517.6508	-5157909.9332	3736955.8065	L3X	0.0146	172
244B	138517.6602	-5157909.9284	3736955.8076	L3PFX	0.0170	
difference	-0.0094	-0.0048	-0.0011			
MEAN	138517.6555	-5157909.9308	3736955.8071			

SACS1 - FAA HZD A

	X	Y	Z	SOLN	RMS	
244F	138244.3948	-5158611.2409	3735995.7541	L1X	0.0057	1
244G	138244.3946	-5158611.2392	3735995.7494	L1X	0.0073	
difference	0.0002	-0.0017	0.0047			

SACS2 - HZD C

	X	Y	Z	SOLN	RMS	
244F	138364.7295	-5158170.6200	3736597.6080	L1X	0.0057	0.5
244G	138364.7285	-5158170.6243	3736597.6115	L1X	0.0073	
difference	0.0010	0.0043	-0.0035			

HARN-GPS 15	Adjusted vs. Published NAD 83					
	X	**Y**	**Z**		RMS	KM
244C obs. (NAD83)	145521.9648	-5141684.5452	3758877.3789	L3X	0.0113	28
published. (NAD83)	145521.9690	-5141684.5610	3758877.3980			
difference	-0.0042	0.0158	-0.0191			

BM1 - F 181	NAD 83 EHT (m)	NAVD 88 (m)				
244D obs.	144.223	172.572		L3X	0.0116	22
published	N/A	172.628				
difference		-0.0560				

BM2 - Y 161	NAD 83 EHT (m)	NAVD 88 (m)				
244E obs.	94.516	122.698		L3X	0.0129	39
published	N/A	122.739				
difference		-0.0410				

Comments: 12 minute gap in CORS data from 1318-1330
GPS 15 also observed in session 242A -see sheet2 for vector comparison
Page 2

ITRF Coordinate Comparison for Multiple Occupied Stations
HARN and Bench Marks

ITRF vector comparison for GPS 15-

HARN-GPS 15	Observed ITRF Coordinates					
	X	Y	Z	SOLN	RMS	KM
244C	145521.3912	-5141683.0467	3758877.2319	L3X	0.0113	28
242A	145521.3883	-5141683.0334	3758877.2145	L3PFX	0.0152	191
Difference	0.0029	-0.0133	0.0174			

ITRF vector comparison for GPS 32-

HARN-GPS 32	Observed ITRF Coordinates					
	X	Y	Z	SOLN	RMS	KM
254C	90432.9992	-5169962.2991	3721755.0682	L1X	0.0099	13
265C	90432.9988	-5169962.3238	3721755.0829	L3X	0.0099	50
266C	90433.0042	-5169962.3131	3721755.0756	L1X	0.0085	17
Max Difference	0.0054	-0.0247	0.0147			

ITRF vector comparison for ...-

APPENDIX 11

PROJECT SUBMISSION CHECKLIST

Project Submission Checklist GPS Projects

FAA Airport Surveying – GIS Program

Project Title:	
Accession Number:	
Submitting Agency:	
Observing Agency:	
Receiver Type:	

PACKAGE CONTENTS

Project Report and Attachments

	Item	Received by NGS			
		Yes	No	Date	Initials
	Project Report				
	Approved Reconnaissance and Project Sketch				
	Final Station List				
	Station Visibility Diagrams				
	Observation Logs				
	Equipment Failure Logs[1]				
	Loop Misclosures[2]				
	Free Adjustment with Analysis				
	Free Adjustment with Accuracies				
	Constrained Horizontal Adjustment				
	Constrained Vertical Adjustment (NAVD88 Heights)				
	Meteorological Instrument Comparison Logs[3]				
	Photographs of views from Stations[4]				
	Photographs or rubbings of Station Marks				
	COMPGB Output (Validation Program – B/G file)				
	OBSDES Output (Validation program – D file)				
	OBSCHK Output (Validation program – D file)				
	CHKDESC Output (Validation program – D file)				
	ELLACC Output				
	BBACCUR Output				

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[1] Required only for NGS contracted projects.
[2] Submission optional.
[3] If specified or requested.
[4] If specified or requested.

Digitized Data Files

Data on diskette	Data on other media (specify):				
Item			Received by NGS		
		Yes	No	Date	Initials
Raw Phase Data (R-files)					
Base Line Vectors (G-file)					
Project and Station Occupation Data (Final B-file)					
Descriptions or Recovery Notes (D-file)					
Terrestrial Horizontal Observation (T-file)[5]					
Differential Leveling Observations (L-file)[6]					

Submitting Agency Identification

Complied by	Name	Section	Date
Checked by	Name	Section	Date
Approved by	Name	Section	Date

National Geodetic Survey Identification

Received by	Name	Section	Date
Reviewed by	Name	Section	Date
Reviewed by	Name	Section	Date

Please provide additional comments on a separate sheet attached to this document.

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[5] If applicable.
[6] If applicable.